Meeting Notes

USDA NRCS
75 High Street, Room 301
Morgantown, West Virginia 26505

- Date: 10/13/2006
- Subject: **Treatment of Richard Mine AMD – Conference to Discuss Progress**

- Notes By: TJ Burr
- Attendees: Bryce Good (Project Manager, GAI Consultants
  Charles Straley (Engineer, GAI)
  Jeff McClure (Geologist, NRCS)
  TJ Burr (Civil Engineer, NRCS)

A meeting with the consulting firm, GAI Consultants, was held from 10:00 AM to 1:00 PM on October 13, 2006. The purposes of the meeting were to discuss the status of deliverables, project schedule, and to start the alternatives portion of the contract (Phase I, Item 3, compilation of alternatives). The official meeting minutes are the responsibility of GAI Consultants.

1. Bryce started the meeting by delivering the final "draft" Evaluation Report, which expanded from 26 to 38 pages in the main body. TJ and Jeff will back-check this to ensure that the review comments were properly incorporated. GAI requested one week to turn the report around and issue the final *evaluation report*.
2. The next phase of work is to complete an *alternatives report* as defined in the design specifications for the project. Bryce said the draft will be done by 11/15/06. The 30-day review period will go until 12/15/06, then the final report will be done by the end of the year. A review meeting will be held the first week of December to discuss the review comments.
3. The basis for the alternatives report was the laundry list of AMD treatment alternatives that were discussed during this meeting. This same list was also shared with many of the project partners that have been involved with the Richard Mine project. Only a few comments were received from this initial list.
4. GAI Consultants will be moving into a new office building in Charleston with the following number, 304-926-8100.
5. GAI prefers to invoice based on completed tasks. So far, the two work items have not been completed and accepted.
6. One of the new additions to the evaluation report was a table listing properties with land areas large enough for possible treatment systems. The purpose of this table was a feasibility of even going forward with the project. GAI agreed that there are tracts of land with enough area to construct an AMD treatment plant, but the availability of being able to use that land is unknown. Other project partners have agreed to assist with landrights research. A rough guess is that at least 3-5 acres will be required to build a minimally-sized AMD treatment system.
7. The WVDEP/AML has discussed increasing the flushing frequency at the Richard Mine seal from bi-annually to quarterly. The existing discharge pipes are becoming too clogged with the current cleaning schedule. This is a problem that will have to be accounted for with any future solution. The

pipes are flowing as open circular channels, not pipes flowing under pressure. This allows the *acid mine drainage* to aerate.

8. The scope of work from the April 10, 2006 contract for Phase I, Item 3, was reviewed line-by-line to ensure that GAI understood what was expected in the *alternatives report.*
9. The treatment alternatives identified were discussed briefly as follows. GAI understood that they do not need to spend vast amounts of time on alternatives that can be quickly dismissed by showstoppers. More details will be provided for the most viable alternatives or combinations of alternatives.

Discussion of AMD Treatment Alternatives and the Current List

The alternatives report will have three major subcategories of treatment methods: 1) active, 2) passive, and 3) innovative. The initial list submitted by GAI contained 34 alternatives. The following represents all of the treatment alternatives proposed by GAI Consultants and others involved with this project (*if anyone knows of other alternatives that should be included on this list, they should send them to TJ Burr by October 31, 2006*):

1. **No action** or "do nothing" – no treatment – let nature resolve the problem with time (lots of time).
2. **Open limestone channels** (OLC) – good iron removal, but will armor with time. Based on the AMD chemistry at the Richard Mine and other problems with using OLC, OLC will not be considered a feasible solution.
3. **Steel Slag-bedded Channel** (SSBC). Steel slag has a low pH (11), but method requires clean water.
4. **Successive alkalinity producing systems** (SAPS) – good iron removal, requires retention time & land.
5. **Reverse alkalinity producing systems** (RAPS). * Added after meeting by TJ *
6. **Aerobic wetlands** – wetland alternatives would require a large tract of land in a suitable location that the AMD could be conveyed to.
7. **Anaerobic wetlands**
8. Other variations of **constructed wetlands** or innovative wetlands. Sphagnum moss bogs have been effective for treating weak AMD (low metal and acidity).
9. Anaerobic **vertical flow reactor**.
10. Limestone Basin, Pond or Bed – tend to clog with iron precipitate; not good with high aluminum, or LLB (limestone leach bed).
11. **Upflow pond** – the use of siphons to reverse flow through a limestone leach bed.
12. **Anoxic limestone drains** (ALD), passive treatment
13. **Limestone sand** (fines) dumping into mine workings, discharge or stream
14. Bioremediation.
15. **Soda ash treatment** – typically used for low flows with low metals/acidity, which probably excludes this method for the Richard Mine AMD stream.
16. **Ammonia** – this would be a type of chemical used with an active treatment system. This is a dangerous chemical to handle with many disadvantages.
17. **Sodium Hydroxide** (Caustic Soda) – this is simply another chemical used in *active treatment* that can be in solid or liquid form. It can be administered with a drip feed or siphon tank system.
18. **Flocculation** – this can be a component of an AMD treatment system to accelerate removal of metals.
19. **Grout Mine**. GAI had direct experience with the potential pitfalls of grouting at the *Omega Mine Complex*. Grouting can also cause unwanted subsidence.

20. Convey and treat at the **Municipal Wastewater Treatment Plant** (MWWTP) – Tim Ball, PE, from the MUB said they would not support this alternative (e-mail to TJ Burr on 1/12/2006). The chemical characteristics of AMD are much different from those of the typical wastewater stream.
21. Convey AMD discharge to the nearest **stormwater system** connection – this was also unacceptable to the MUB for reasons stated in Mr. Ball's e-mail of January 12, 2006.
22. **Conveyance to large body of water** (e.g., Mon River) for **dilution or dispersion** – technically this could be a viable solution with some of the lowest long-term maintenance costs, but public perception, environmental permitting, and initial construction costs would be prohibitive.
23. **Greer pond** – the use of high alkalinity wastewater from the Greer Limestone quarry.
24. **Calcium carbonate** – this is the primary ingredient in limestone that makes it attractive for AMD treatment.
25. **Injection of limestone** or other chemicals into the mine, which could be categorized as an *in-situ treatment method*. In general, *in-situ treatment methods* are likely to be expensive due to the large amount of chemicals and pumping required.
26. Active treatment with **pebble quicklime** (calcium oxide). Some key components of this alternative would include a storage silo, electronic mixer, channels, and settling ponds. The use of pebble quicklime is popular and cost effective. Many systems using packaged *AquaFix* units are in use throughout West Virginia.
27. Injection of **lime kiln dust** (LKD) or other type of active treatment using LKD.
28. Active treatment using **magna lime**.
29. **Ion Exchange** – used for metal recovery or polishing of wastewater. Requires a complex system of piping, valves and tanks.
30. **Electrodialysis** – this could be considered a component of a treatment system, but is in the same category as ion exchange and reverse osmosis as being experimental and complex.
31. **Reverse Osmosis** – there was no discussion regarding this alternative.
32. **Aeration and oxidation**. These could be components of a treatment alternative.
33. **Fine Bubble Aeration** – small packaged systems developed by Jon Dietz.
34. **Diversion well** – the use of a well to divert the flow through a treatment system?
35. Active treatment using **fly ash** (or FBC Ash) or injection of fly ash into the mine pool. Other methods of active treatment of the mine pool?
36. Injection of **sewage sludge** into the mine as a form of biological treatment.
37. **Biological source treatment** by introducing biological materials into the mine pool. Treatment of weak AMD has been accomplished with substrates, such as lactate, spoiled milk, ethanol, and glycerol.
38. **Inundation** of the mine to reduce or eliminate air contact with AMD-producing elements. With the large portion of developed land surrounding the Richard Mine, this would be a risky alternative.
39. **Sulfide tailings** – the use of a waste product, but probably not viable in this case.
40. *In-situ treatment* using **Inert gas injection** or other forms of injection treatment – this is a method of alkaline treatment within the mine. There are many possible ways to boost the alkalinity of mine pool water.
41. *Active treatment* using **hydrated lime**.
42. **Rotating cylinder treatment system** (RCTS) – uses perforated rotating cylinders to add oxygen from the atmosphere. These were discussed at the 2005 Mine Water Treatment conference in Pittsburgh (www.treatminewater.com).
43. **Activated Iron solids** (AIS) treatment, developed by Jon Dietz, produces high-density solids (30%). Reported to be cost-effective on high flow rates with high iron contents. However, the acidity may have to be reduced before flowing into AIS system.
44. Pulverized limestone aluminum removal (PLAR), also developed by Jon Dietz
45. **Re-circulation** of AMD into the mine.

46. **Sulfate reducing bioreactors** (SRBs) – Jim Gusek, *Golder Associates* is a leader in this technology. These treatment systems use organic substrates (wood chips, sawdust, rice hulls, yard waste, mushroom compost, animal manure, hay, straw, nut shells, antifreeze, etc.). These systems can be self-sustaining and last up to 20-years.
47. Passive **ethanol bioreactors** were used on the Leviathan Mine (superfund site) in Nevada, but are only good for weak AMD chemistry. * Added after meeting by TJ *
48. Innovative, self-contained treatment systems as developed by Jon Dietz.
49. Limestone diversion well – divert flow through tank filled with crushed limestone
50. Various **in-stream treatment methods** within Deckers Creek – would require the sacrifice of a portion of Deckers Creek and would be difficult to permit. An example would be a 6-drum system or in-stream impoundments.
51. Return/Inject **pond sludge** back into mine pool – this may become part of the recommended alternative to eliminate the large cost of trucking sludge to a landfill.
52. Pump mine pool via borehole to the extent that discharge at Richard ceases. Discharge into West Run either with no treatment or with some treatment. This could provide an alternate location for treatment.
53. **Pumping and treatment** would include sealing all known discharge points, installing collection wells, then actively treating the AMD. Some potential pitfalls include possible over-pumping causing subsidence, and massive volumes of sludge.
54. **Grout sealing** of fissures into the mine to seal out ground water infiltration – excess infiltration is not suspected in this case.
55. **Surface water diversions** – GAI believes that most of the water in the mine pool is from normal surface infiltration across the mine works and groundwater inflows. There are no easy targets available for improving the situation with surface water diversions. * Added after meeting by TJ *
56. **Combinations of alternatives**, such as grout sealing to reduce the discharge and treatment.
57. Innovative **sludge collection** as a component of a treatment system – the use of ***Geotubes*** to collect and consolidate the sludge (see *Skelly & Loy* project, I-99 construction site, State College, PA). Can get solids of sludge to 35.4% versus 1.15% total solids in settling ponds!

No attempt was made to prioritize the known treatment alternatives. However, a good faith effort was made to identify the known AMD treatment alternatives representing the state of the art. GAI Consultants are encouraged to add any new or innovative treatment methods or acceptable alternatives they may become aware of between now and the completion of the *alternatives report*.